# A Variable Condenser Miniature Microphone System

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## 1. State of the Art

### The Transformerless Microphone

It is now five years since we introduced our first transformerless microphone for 48 V phantom powering .
This, the "TLM 170", is provided with some quite elaborate circuitry consisting of an amplifier and a dc converter. The complex circuitry is necessary in order not just to replace the hitherto conventional transformer by a balanced output stage, but also to ensure that nothing of the desirable properties of the former is lost.

These are, for example:

- Power matching of the standardised 48 V phantom powering feed technique (relatively high voltage with lowest possible feed current) to the attainable output voltage of the microphone for high modulation reserves at highest possible output current, in order to be able to cope with the complex load of long modulation cables and low terminal impedances.

- The very effective protection against stray RF fields, which are liable to reach the microphone via the cable. This is especially the case when the transformer is provided with a static screen winding between the primary and secondary side.

Transformerless modulation paths are desirable because even with high-quality magnetic materials and generous dimensioning, some of the disadvantages of

transformers cannot be entirely circumvented, such as, for example,

- Frequency-dependent impedance,
- Distortion of lowest frequencies with high magnetisation,
- Distortion with very low magnetisation,
- Susceptibility to external magnetic fields,
- High volume and weight.

In contrast, the transformerless circuitry of the TLM 170 results, among other things, in

- remarkably high loadability over the entire range of response
- particularly clean, free and uncoloured sound reproduction
- frequency-independent image sharpness, without any preponderance of partial frequencies in the foreground. Complex sounds are reproduced in *one* single acoustic plane.

## 2. The New Miniature Microphone System

### The Hybrid Technique

In order to make the successful circuit technology of the TLM 170 available also for miniature microphones, we have developed two hybrid modules with an edge length of 17 x 11mm which enables them to be accommodated in a microphone tube with a 20 mm inside diameter.

Hybrid technology is a method of engineering a circuit combining miniaturised components *(SMD technique)* with resistors made of conductive hardened paste and conventional components, such as the field effect transistor for the input stage, selected, as hitherto, for its low-noise characteristics.

Two different hybrid modules operate together to form the microphone circuit: the **AF amplifier** and the **dc converter**, which delivers two stable dc voltages from the 48 V phantom powering circuit:

10 V supply voltage to the AF amplifier
50 V for capsule polarisation.

By using these modules, the length of the microphone has been reduced to 92 mm - which is even 18 mm shorter than its predecessor, the KM 84 i (Fig.1).

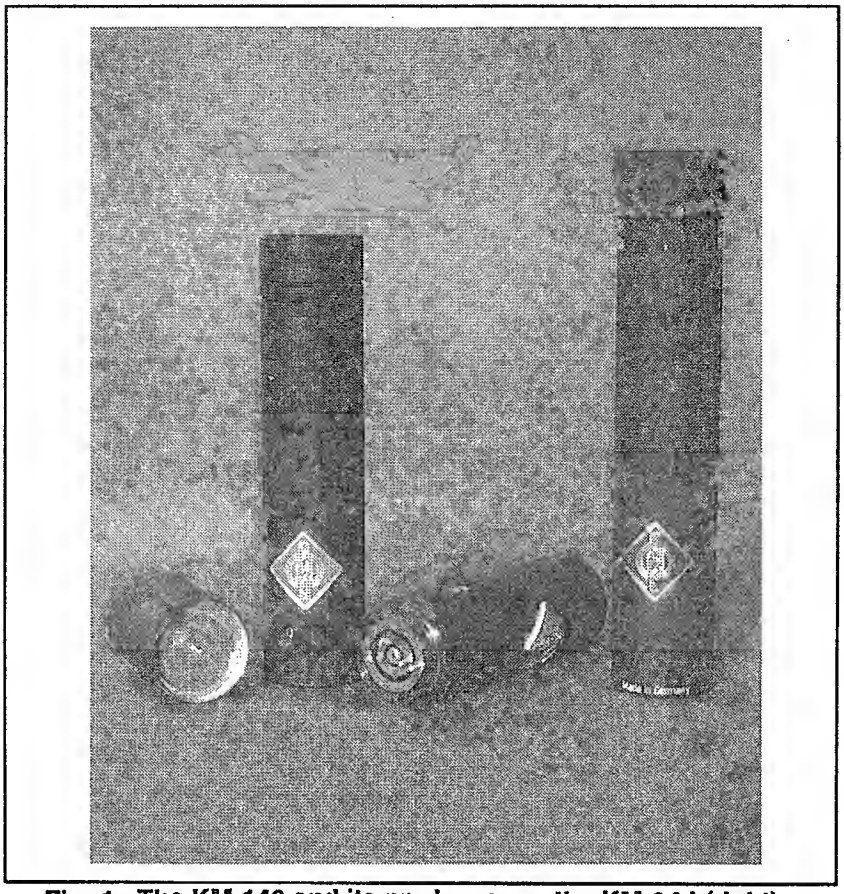

**Fig. 1 The KM 140 and its predecessor, the KM 84 i (right)**

## Operation with detached capsules

The new miniature microphone system was designed not only to have interchangeable capsules so as to cope with diverse pickup situations by varying the directional characteristics, but also to accommodate a wide selection of accessories in the form of extensions between the capsules and the amplifier, so as to make the system as flexible as possible.

However, as is well known, the high impedance of a microphone capsule with AF circuitry requires an electronic impedance converter to be added in series as directly as possible.

For this reason the operation of a microphone capsule detached from the amplifier so as to make the microphone appear as small as possible is dependent on two conditions:

- either by restricting its electroacoustic data and imperviousness to interference (depending on its distance from the amplifier),
- or by following it directly with an impedance converter built into the head of a cable or other accessory connecting the capsule with the microphone circuit.

A solution on these lines was provided, for instance, by the KMF 4 i Neumann Miniature Microphone with flexible capsule extension. However, a sufficiently small impedance converter consisting of discrete components (as in the KMF 4 i) would have been like the eye of a needle for the qualitatively much superior transformerless follow-on circuit.

**The Microphone Circuit in the Capsule**

As a result of the extreme compactness of the microphone circuit as a hybrid module, we are now able to dispense with an additional impedance converter in accessories, and fit the complete AF amplifier in the capsule housing.

The microphone thus becomes an "**Active Capsule**" (Fig. 2).
This opens up the possibility of adding any desired accessories without any effect on the quality of reproduction.
The microphone capsule can be screwed on to accessories such as cables, capsule extensions, swivel mounts, desk stands, goosenecks, stereo mounts and suspension equipment, being in itself only 35 mm long.

The remaining part of the microphone case contains the capacitors for decoupling the signal, the dc converter, a slide switch for reducing the output level by 10 dB and the XLR plug connector, which occupies a lot of space itself.

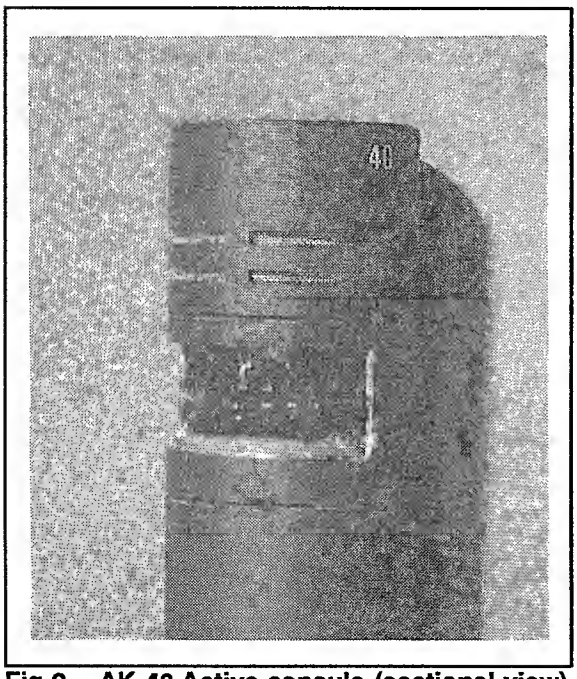

**Fig 2 AK 40 Active capsule (sectional view)**

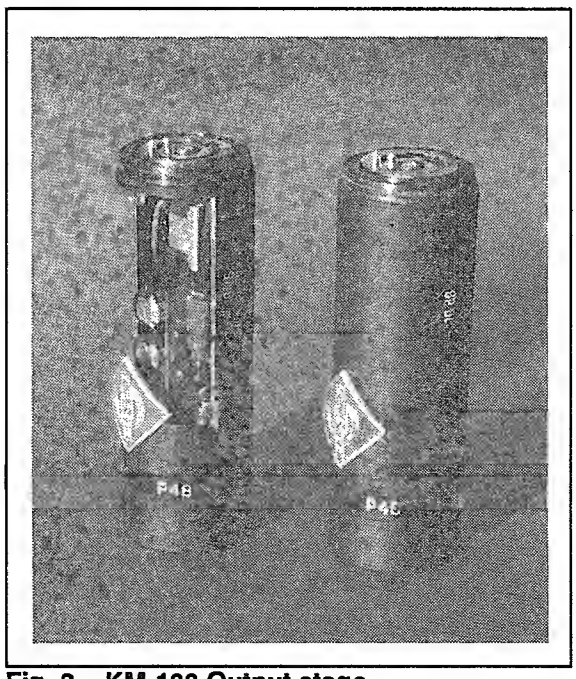

**Fig. 3 KM 100 Output stage**

## Interference resistance

When a detached capsule is connected with the amplifier circuit of the type exemplied by the KMF 4 i, the result is an unbalanced line which is normally less immune to hum and switch-clicks than the balanced line between microphone and mixing console. On the one hand this is because there is very little room in the head of the "active accessory" for elaborate electronic counter-measures, but on the other hand, it may be powerfully affected by the cable configuration in use.

The new miniature microphone system benefits

a) by the fact that it contains the entire microphone circuit in the Active Capsules, thus affording excellent protection against switch-clicks and also against phase gating controls, and
b) by the use of a newly developed cable to connect the Active Capsule with the output stage.

This is constructed on the lines of our normal microphone cables, which are screened by *double-twist braiding* and have proved to be particularly RF-proof.
This cable is only 3.2 mm thick and very flexible. At the same time, care has been taken to ensure that it is free from any internal twist, which might otherwise cause, for example, an Active Capsule hanging free from the ceiling to rotate in an unwanted direction.
These measures make the new microphone system some 30 dB less susceptible to RF and switch-clicks than a KMF 4 or similar microphone construction in a comparable test set-up (Fig. 4) [1].

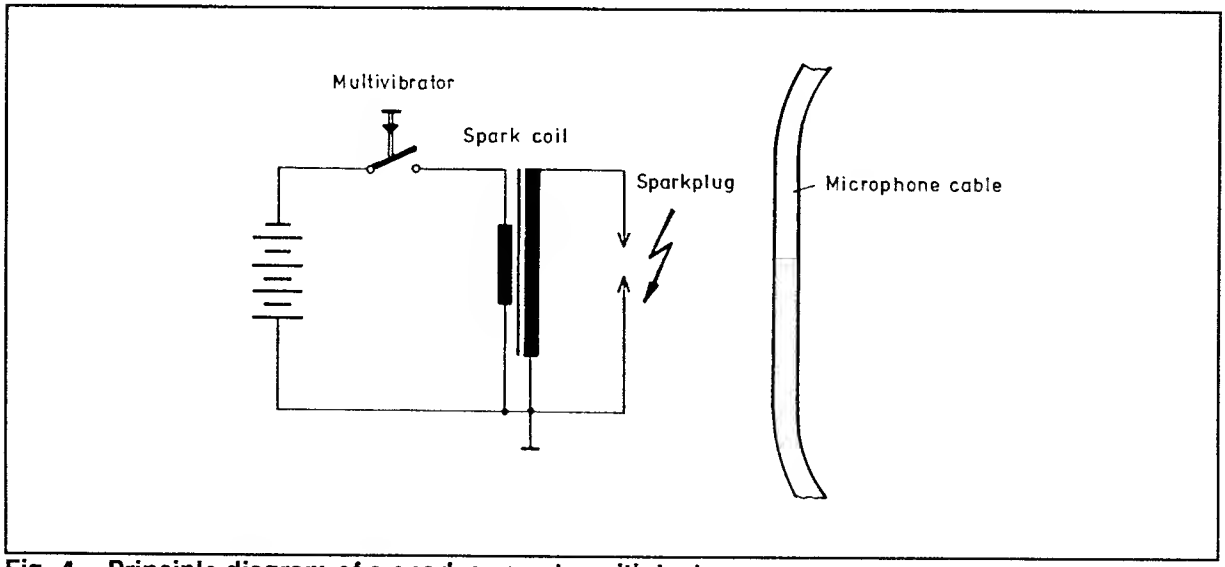


**Fig. 4 Principle diagram of a spark generator with test**

1) Wide-band spark generator at 10 cm distance from cable
Unweighted intrinsic noise level of microphone with and without depicted spark generator.

## The Active Capsules

Various Active Capsules are available:

a) The diffuse-field compensated pressure receiver (omni-directional polar pattern) has a free-field treble lift of about 7 dB at 10 kHz, which makes the diffuse-field frequency response flat up to 10 kHz. The frequency response depicted in Fig. 5 in conjunction with the deliberate complete absence of any post-equalisation in the amplifier makes for an almost ideal transient response of this and the subsequently described capsules. Among other things, this results in a particularly natural and transparent response in the bass range and to precise reproduction of the fine structures of complex sounds.

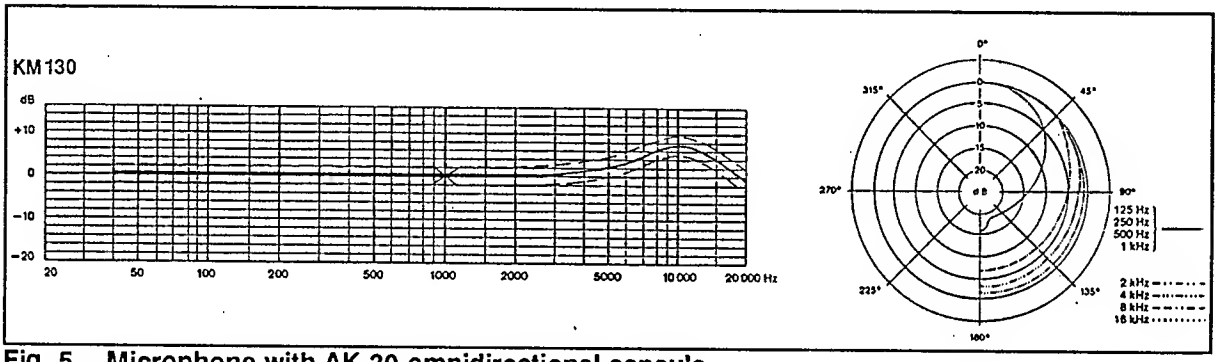


**Fig. 5 Microphone with AK 30 omnidirectional capsule**

b) The pressure gradient receiver with cardioid polar pattern displays very even frequency curves parallel to the sound incidence angle 0°. Consequently, sound over a pick-up angle of ±135° is reproduced without any colouration, and the microphone has a level frequency response in either free or diffused field. Its sound character is therefore unaffected by the critical distance of the recording premises (Fig. 6). As a pressure gradient receiver, this capsule has the property of lending a lift to the bass range of very close-proximity sounds ("Proximity Effect" [1]). As a result, when it is used for speech or song the slightest differences in spacing become audible parts of the sound pattern and lend a lifelike presence to the performance.

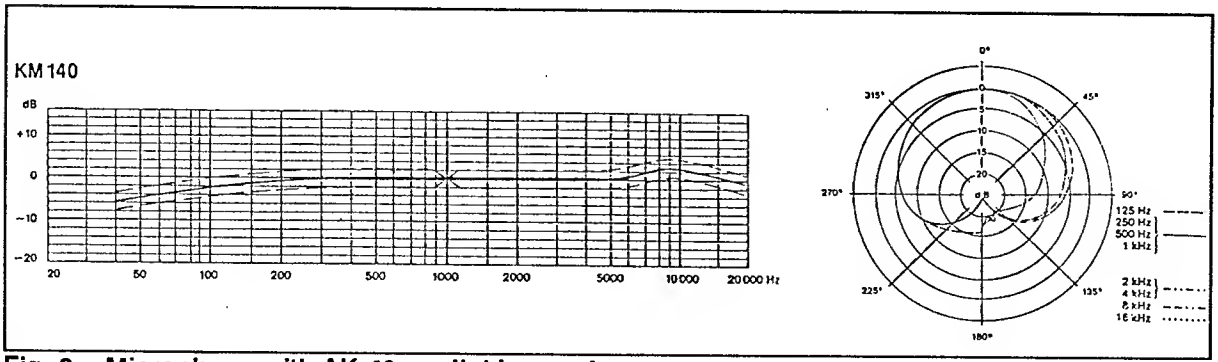


**Fig. 6 Microphone with AK 40 cardioid capsule**

c) For extremely short speaking distances, and for cases where a bass lift would be undesirable, a pressure gradient receiver is required which, with reference to the free, level sound field, has a low-frequency roll-off ("speech cardioid", Fig. 7). Here again, as a result of the proximity effect, level reproduction of the overall audible sound occurs first at a distance of about 15 cm from the sound source. This capsule likewise has a cardioid characteristic, being otherwise similar to the capsule described in b). The low-frequency roll-off is achieved by the use of a very tightly-stretched membrane. This receiver is thus noticeably less sensitive to low-frequency extraneous sounds, such as wind noise and solid-borne sound, than a cardioid microphone with a linear frequency response.

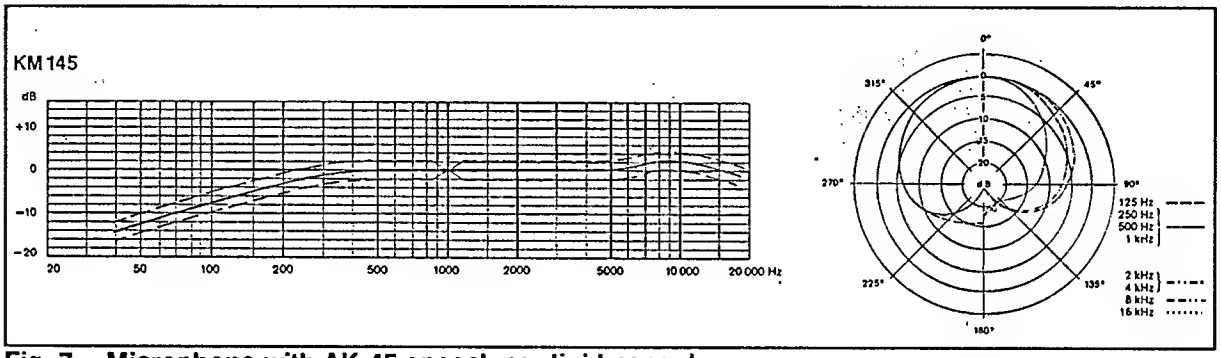


**Fig. 7 Microphone with AK 45 speech cardioid capsule**

d) Whereas a "cardioid" suppresses sound impinging from the side by 6 dB and is most insensitive to sound from the rear (approx. -20 dB ref. 0° sound incidence), it can sometimes be advantageous to obtain a narrower "focusing" of the sound in the front half-space. This can be achieved with a hypercardioid capsule (Fig. 8), which suppresses sound impinging from the side by 10 dB, and has as its region of lowest sensitivity the generated surface of a 120° cone about the microphone axis. It must be added, however, that the sensitivity coefficient of this type of transducer with regard to sound from the rear (120°...180°) undergoes an increase, and rearward sound is suppressed by "only" 10 dB.

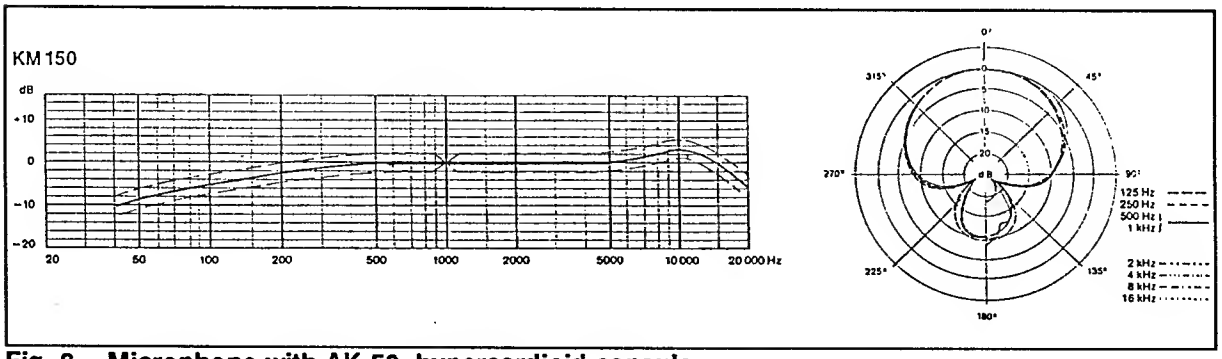


**Fig. 8 Microphone with AK 50 hypercardioid capsule**

The hypercardioid characteristic is thus most especially suitable when it is important to give prominence to frontal sound in contrast to ambient noise. Moreover the "blind angle" sector of 120° can be more favourable for many applications than the 180° of the cardioid characteristic.

**Accessories**

As mentioned in the foregoing, the principle of Active Capsules permits the use of a great variety of accessories with the purpose of obtaining a small, unobtrusive, microphone of high quality and resistance to interference for the widest possible range of applications. Thus, the Active Capsule can be suspended vertically or at an angle from the ceiling on a very flexible, thin cable.

In addition, two capsules can be suspended from the ceiling or fixed to a stand in a stereo mount at any required angle of offset to constitute an extremely small coincident stereo microphone. An additional bracket on the stereo mount fixes two microphones in the stereo position known as the ORTF configuration: 17 cm apart at an offset angle of 110°. This results in mixed intensity and time delay stereophony.

The list of accessories is completed by various swivel stand mounts, auditorium hangers, desk stand bases and elastic suspensions .

**Some technical data**

Some further properties which distinguish the new **KM 100** family of microphones from the comparable predecessor series **KM 80** are singled out for mention below:

- Sensitivity is some 3 dB higher, so that for the same sound pressure, a greater useful signal arrives at the mixing desk.
- The signal-to-noise ratio is improved by 3 dB.
- It was found possible to raise the max. SPL by some 17 dB, thus making the dynamic range about 20 dB greater than with conventional microphones.
- With the same microphone diameter of 21 mm as hitherto, the complete microphone is now 18 mm shorter. The capsule section, detached from the output stage, is only about 35 mm long.

**LITERATURE**

[1] MICROPHONES for professional and semi-professional applications
Dr. Ing. Gerhart Boré · Georg Neumann GmbH, Berlin
August 1989